PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in Powder Metallurgy

We, HÖGANÄS-BILLESHOLMS AKTIEBOLAG, a Swedish company, of Höganäs, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

In powder metallurgy iron powder is very seldom used alone for the production of pressed and sintered machine parts. It has been found that the strength of the pressed and sintered parts is improved considerably if the iron powder to be used is mixed with up to 20 per cent of copper powder. In practice between 5 and 10 per cent of admixed copper is used as a rule.

However, it has been proved in practice that different iron powders mixed with copper, during sintering in hydrogen gas at 1100—1150° C. after pressing, behave differently according to the method of production. Certain iron powders on sintering show a considerable swelling or increase in dimensions (up to about 2.3 per cent), while other powders show a shrinkage of up to 0.7 per cent. As it is desirable, in order to maintain the required tolerances, that the change in dimensions during the sintering operation be as small as possible, it is common practice when copper is to be included in the powder to mix a powder that swells with a powder that shrinks so that the mixture used does not show any change in dimensions or only a slight swelling (up to about 0.3 per cent) after pressing and sintering. The reason a small swelling is sometimes desirable is that in such cases the same pressing dies can be used in the pressing operation as in the calibration operation after the sintering.

Of course it is a drawback for the manufacturer of iron powders that his powder cannot be used alone in the manufacture of copper-alloyed parts, and consequently much work has been done in order to overcome the swelling or increase in dimensions.

The present invention, which provides a solution of this problem, is based upon the surprising discovery that relatively small amounts of admixed tungsten, in the form of metal powder, or a pulverous tungsten compound such as tungsten oxide, ferrotungsten or tungstate, or a highly-concentrated tungsten mineral such as wolframite, considerably decrease the swelling of a powder which normally swells together with copper and that greater amounts can even bring about shrinkage. With such additions, furthermore, the tensile strength is considerably improved.

The table below illustrates the influence of tungsten oxide mixed with iron powder and copper powder. The pressure was about 5 metric tons per sq. cm., and the sintering was carried out in a hydrogen atmosphere at about 1150° C. for 60 min. The measurements were made in cylindrical samples having, before sintering, a diameter of 25 mm.

[*Price* 2/8]

TABLE I.

Composition of mixture	Alteration in diameter	Tensile strength
92.5 g Fe+7.5 g Cu+0 g WO_3	+1.93%	25.9 kg/mm²
92.5 g Fe+7.5 g Cu+0.5 g WO_3	+0.44%	35.8 ,, / ,,
92.5 g Fe+7.5 g Cu+1.0 g WO_3	+0.13%	39.5 ,, / ,,
92.5 g Fe+7.5 g Cu+2.0 g WO_3	−0.19%	43.0 ,, / ,,
92.5 g Fe+7.5 g Cu+3.0 g WO_3	−0.30%	44.1 ,, / ,,

As is seen from the table even such a small addition of tungsten oxide as 0.50% has quite a surprising effect on the alteration in dimensions as well as on the tensile strength.

It has been proved, however, that the effect of added tungsten or a tungsten compound is influenced by different circumstances such as the amount of intermixed copper, the sintering temperature, the sintering time and finally in a very marked way by the pressure used or, which is the same, by the density of the pressed but not sintered compacts ("green density"). This can be seen from the table below, where is shown the effect of small amounts of added WO_3 on the dimensional change during sintering of cylindrical compacts having a diameter of 25 mm but with different green density. It is seen that if the green density be kept as low as 5.5—6.0 grams per cc. (corresponding to a pressure of 2—3.5 tons per cm²), which is often the practice in powder metallurgy, an added amount of only 0.15—0.20% WO_3 is enough to keep the growth of the compacts during sintering below the permitted upper limit under the conditions obtaining. These conditions are: 10% intermixed copper, sintering temperature 1120° C. and sintering time 30 min.

TABLE II.

Composition of mixture	Dimensional change (diam.) Green density 5.5	Green density 6.0	Green density 6.5
90 gr Fe+10 gr Cu+0 gr WO_3	+1.98%	+2.10%	+2.04%
90 gr Fe+10 gr Cu+0.1 gr WO_3	+0.62%	+0.82%	+1.14%
90 gr Fe+10 gr Cu+0.2 gr WO_3	−0.02%	+0.12%	+0.66%
90 gr Fe+10 gr Cu+0.3 gr WO_3	−0.12%	±0.00%	+0.36%
90 gr Fe+10 gr Cu+0.4 gr WO_3	−0.20%	+0.06%	+0.36%

Continued investigations have shown that a further decrease of the swelling or an increase of the shrinkage is obtained if in addition to tungsten or a tungsten compound there is added to the powder mixture a small quantity of chromium or a chromium compound. The effect of an addition of 0.5% Cr_2O_3 is seen from a comparison of the figures of Table III with the figures of Table I, the figures of Table III likewise relating to cylindrical samples having, before sintering, a diameter 25 mm.

TABLE III.

Composition of mixture	Alteration in diameter	Tensile strength
92.5 g Fe+7.5 g Cu+0.5 g Cr_2O_3 +0 g WO_3	+1.95%	25.0 kg/mm²
92.5 g Fe+7.5 g Cu+0.5 g Cr_2O_3 +0.5 g WO_3	+0.25%	34.2 ,, / ,,
92.5 g Fe+7.5 g Cu+0.5 g Cr_2O_3 +1.0 g WO_3	+0.03%	38.4 ,, / ,,
92.5 g Fe+7.5 g Cu+0.5 g Cr_2O_3 +2.0 WO_3	−0.25%	38.1 ,, / ,,
92.5 g Fe+7.5 g Cu+0.5 g Cr_2O_3 +3.0 WO_3	−0.04%	42.5 ,, / ,,

Surprisingly enough chromium oxide has no appreciable effect when used alone but is effective only in combination with tungsten or a tungsten compound. By using tungsten or a tungsten compound in combination with chromium or a chromium compound the desired effect can be obtained by means of a smaller quantity of the more expensive tungsten or tungsten compound.

It has also been found that tungsten alone or in combination with chromium has this powerful effect only if intermixed with previously reduced metallic powder. Intermixture with iron oxide before the reduction thereof to sponge iron or iron powder has not the desired effect. In order to decrease or eliminate the swelling taking place when sintering in a hydrogen atmosphere compacts produced from certain iron powders in admixture with copper powder according to the invention it is necessary either before, during or after the intermixing of the copper powder also to add small quantities of tungsten in the form of powdered metal or a metal compound, possibly together with small quantities of chromium also in the form of powdered metal or a metal compound.

What we claim is:—

1. The method of counteracting the swelling or increase in dimensions and of increasing the tensile strength of moulded parts produced by pressing and sintering in a hydrogen atmosphere iron powder admixed with copper powder characterized in that the pulverous mixture, before pressing and sintering, is mixed with small quantities of a powder containing or consisting of tungsten in metallic form, in the form of an alloy such as ferrotungsten, in the form of a tungsten compound such as tungsten oxide or a highly concentrated tungsten mineral such as wolframite.

2. The method according to Claim 1, in which metallic tungsten or a tungsten alloy or compound is admixed in an amount below 3% and preferably between 0.15 and 0.5%.

3. The method according to Claim 1 or to Claim 2, in which a small quantity of chromium in the form of metal, oxide or highly-concentrated chromium ore is included in the pulverous mixture.

4. The method of counteracting the swelling and of increasing the tensile strength of parts produced by pressing and sintering a pulverous mixture of iron and copper, substantially as hereinbefore described.

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